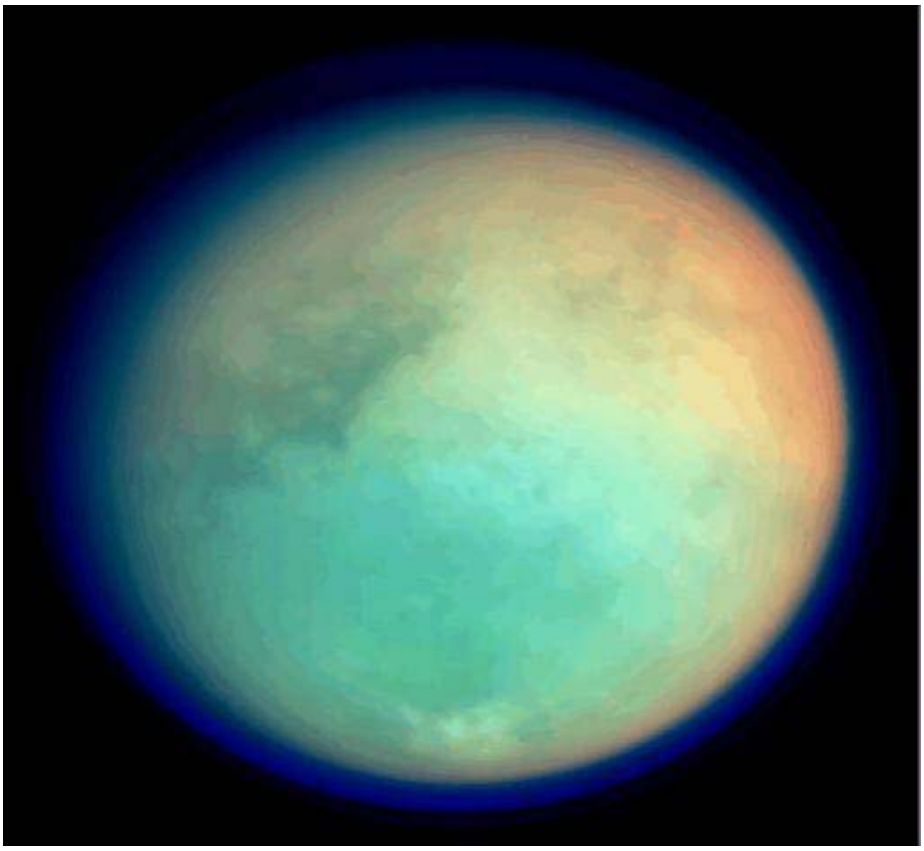
C A S S I N I



T I T A N 025TI(T15)
MISSION DESCRIPTION

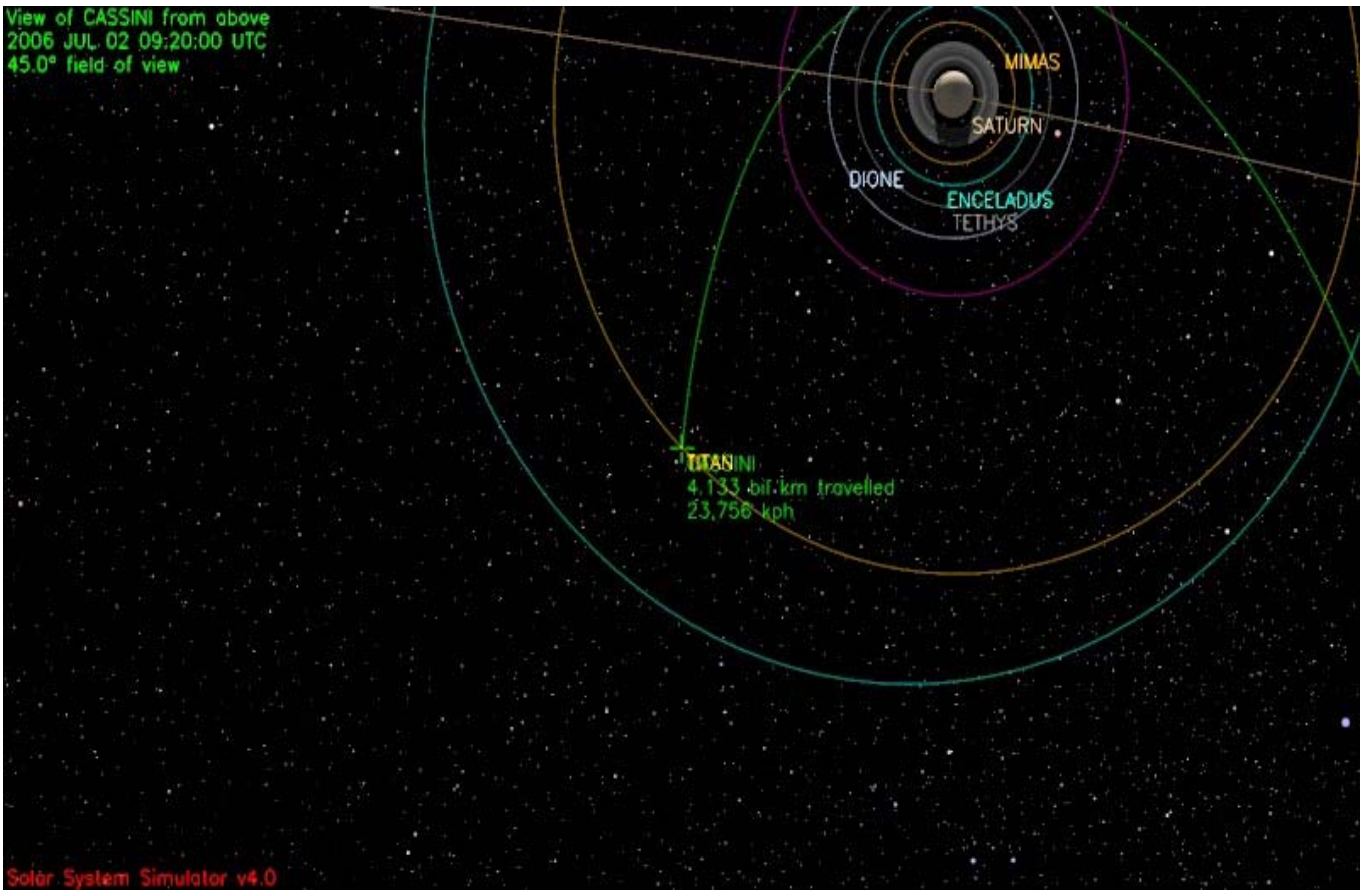
July 2006

Jet Propulsion Laboratory
California Institute of Technology

1.0 OVERVIEW

Forty three days after Titan-14, Cassini returns to Titan for its sixteenth targeted encounter. The closest approach to Titan occurs on Sunday, July 2, at 09:21 spacecraft time (3:43 AM Pacific Time) at an altitude of 1,906 km (1,184 miles) above the surface and at a speed of 5.8 kilometers per second (12,977 mph). The latitude at closest approach is -0.4° (near equatorial) and the encounter occurs on orbit number 25.

This encounter is set up with two maneuvers: an apoapsis maneuver on June 7, and an approach maneuver, scheduled for June 29. This outbound encounter occurs about 2 days after Saturn closest approach.



1.1 ABOUT TITAN

If Titan were in orbit around the Sun, it would likely stand out as the most important object in the solar system for humans to explore. Titan, the size of a terrestrial planet, has a dense atmosphere of nitrogen and methane and a surface covered with organic material. It is Titan that is arguably Earth's sister world, and the Cassini-Huygens mission considers Titan among its highest priorities.

Although it is far colder and lacks liquid water, the chemical composition of Titan's atmosphere resembles that of early Earth. This, along with the organic chemistry that takes place in Titan's atmosphere, prompts scientists to believe that Titan could provide a laboratory for seeking insight into the origins of life on Earth. Data from the Huygens probe, which touched down on Titan's surface in January 2005, and the Cassini orbiter has shown that many of the processes that occur on Earth also apparently take place on Titan – wind, rain, volcanism, tectonic activity, as well as river channels, and drainage patterns all seem to contribute in shaping Titan's surface. However, at an inhospitable -290 ^{0}F (-179 ^{0}C), the chemistry that drives these processes is fundamentally different from Earth's. For example, it is methane that performs many of the same functions on Titan that water does on Earth.

The Huygens probe landed near a bright region now called Adiri and photographed light hills with dark river beds that empty into a dark plain. It was believed that this dark plain could be a lake or at least a muddy material, but it is now known that Huygens landed in the dark region, and it is solid. Scientists believe it only rains occasionally on Titan, but the rains are extremely fierce when they come.

Only a small number of impact craters have been discovered. This suggests that Titan's surface is constantly being resurfaced by a fluid mixture of water and possibly ammonia, believed to be expelled from volcanoes and hot springs. Some surface features, such as lobate flows, appear to be volcanic structures. Volcanism is now believed to be a significant source of methane in Titan's atmosphere. However, there are no oceans of hydrocarbons as previously hypothesized. Dunes cover large areas of the surface.

The Cassini-Huygens mission, using wavelengths ranging from ultraviolet to radio, is methodically and consistently revealing Titan and answering long-held questions regarding Titan's interior, surface, atmosphere, and the complex interaction with Saturn's magnetosphere. While many pieces of the puzzle are yet to be found, with each Titan flyby comes a new data set that furthers our understanding of this world as we attempt to constrain scenarios for the formation and evolution of Titan and its atmosphere.

1.2 TITAN-15 SCIENCE HIGHLIGHTS

As we approach Titan, the Visual and Infrared Mapping Spectrometer (VIMS) will make a global map of Titan; the Composite Infrared Spectrometer (CIRS) will be measuring trace constituents of CO, HCN, and CH4 in Titan's atmosphere, while the Imaging Science Subsystem (ISS) will use their Narrow Angle Camera (NAC) to also make a global map of Titan.

At 5 hours before Titan closest approach, the Cassini Radar will be placed in a passive mode called Radiometry, receiving energy emanating from the surface of Titan. This provides Cassini scientists with information regarding the moon's surface properties. At 1 hour 15 minutes before closest approach, the Radar will be switched to active mode to perform Scatterometry measurements. Instead of creating Radar images, this mode of operation allows scientists to study the composition of Titan's surface. These Radar Scatterometry measurements will only last 15 minutes, and then the spacecraft control is handed over to the Magnetospheric and Plasma Science (MAPS) instruments.

The MAPS instruments will control the spacecraft attitude for 90 minutes around closest approach to perform in-situ measurements of Titan. Some of the MAPS teams consider this period to be ideal for analyzing the plasma wake structure around Titan, the escape of ions from Titan, and Titan's interaction with Saturn's magnetosphere.

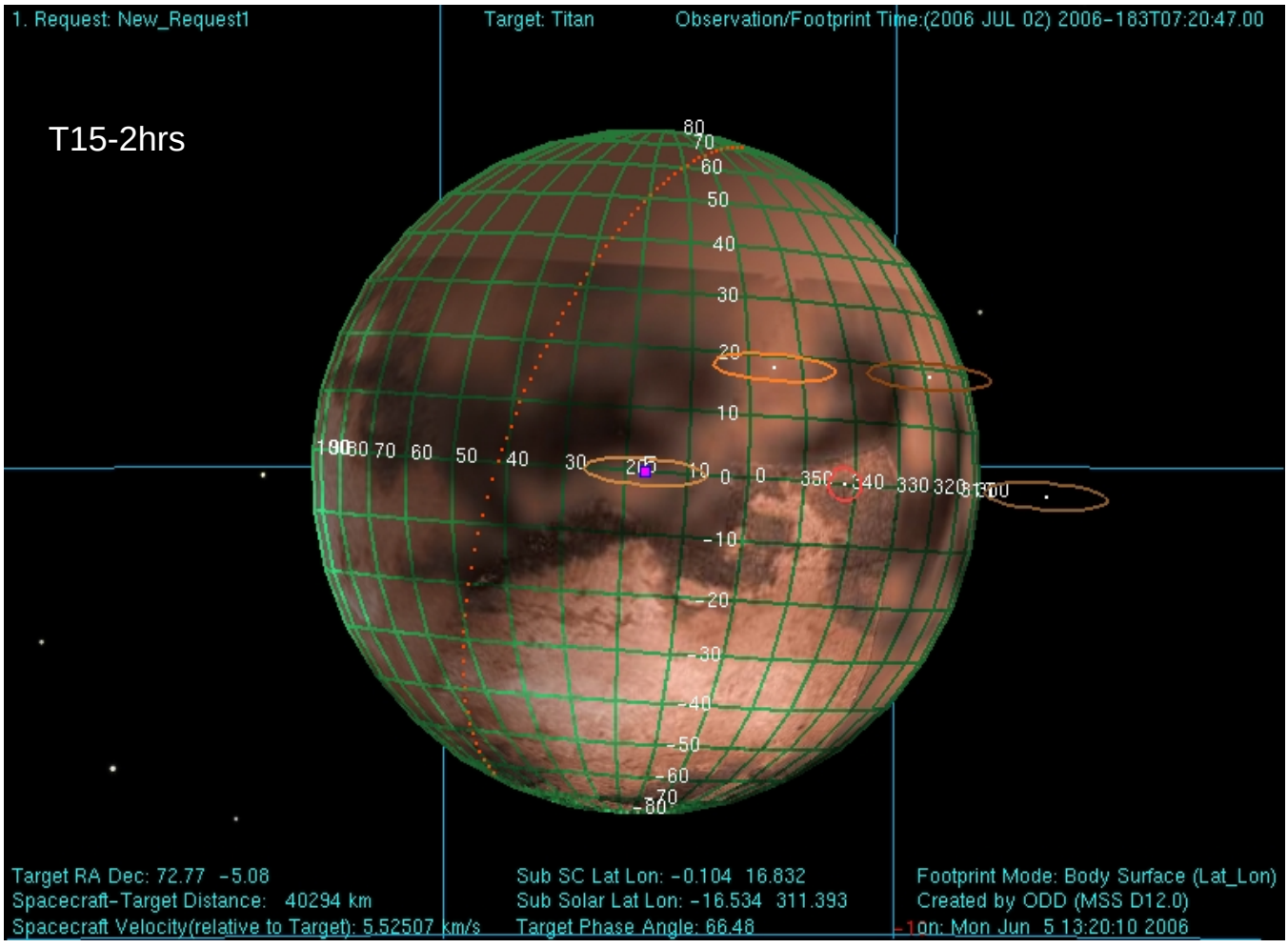
For the outbound leg of the T15 flyby, we return control of the spacecraft to the Remote Sensing instruments. The CIRS instrument will perform vertical aerosol sounding of Titan's stratosphere. This is followed by the Ultraviolet Imaging Spectrograph (UVIS) scans across Titan's visible hemisphere and the ISS instrument's night side search for and monitor of lightning/aurora. The flyby concludes with CIRS measurements of trace constituents and thermal structure in Titan's stratosphere.

1.3 SAMPLE SNAPSHOTS

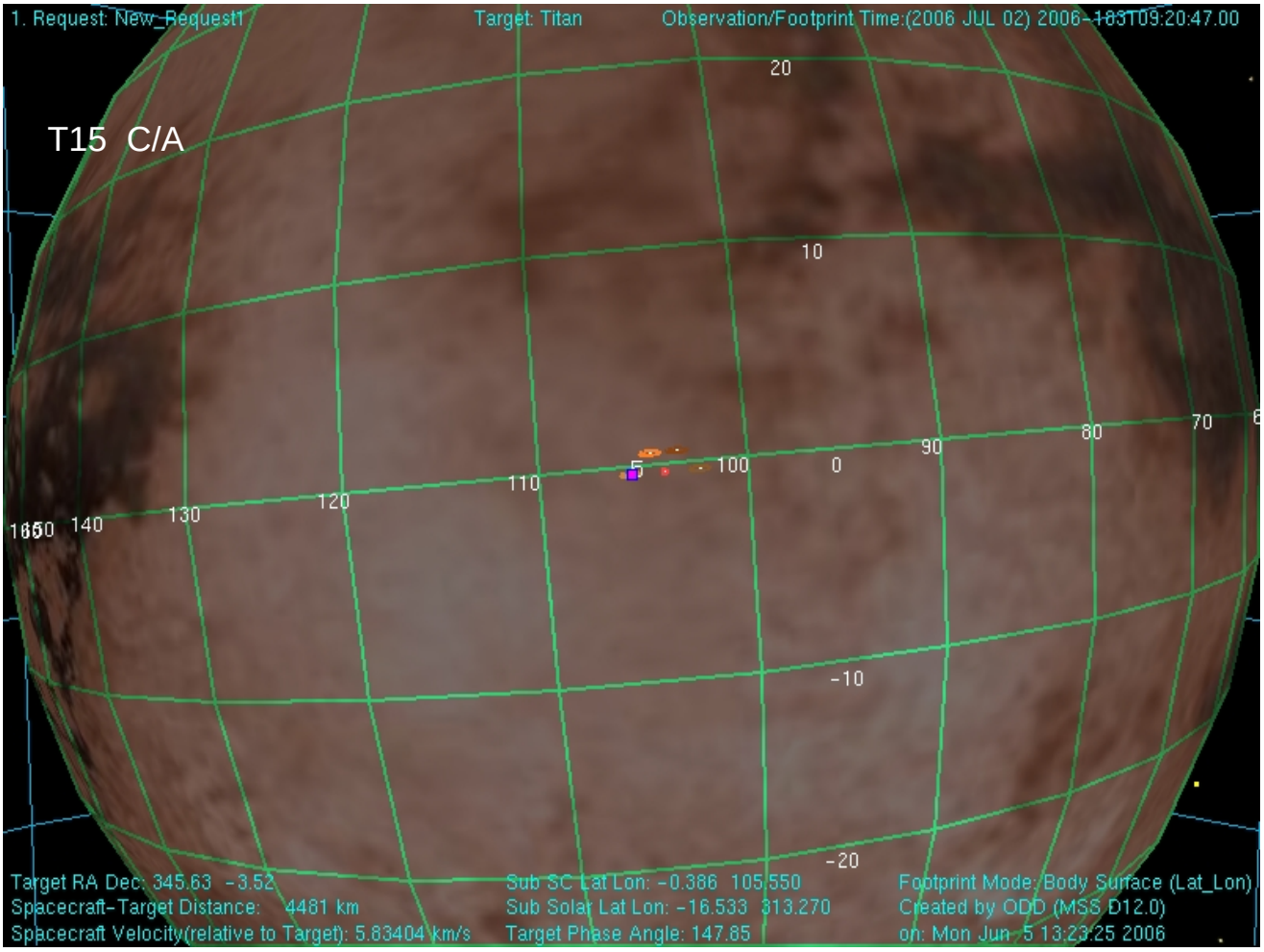
Three views of Titan from Cassini before, during, and after closest approach to Titan are shown below. The views are oriented such that the direction towards the top of the page is aligned with the Titan North Pole. The five Radar beams are shown in the first two views and the remote sensing instrument fields of view are shown in the third assuming they are pointed towards the center of Titan. The sizes of these fields of view vary as a function of the distance between Cassini and Titan. A key for use in identifying the remote sensing instruments fields of view in the figures is listed at the top of the next page.

Key to ORS Instrument Fields of View in Figures

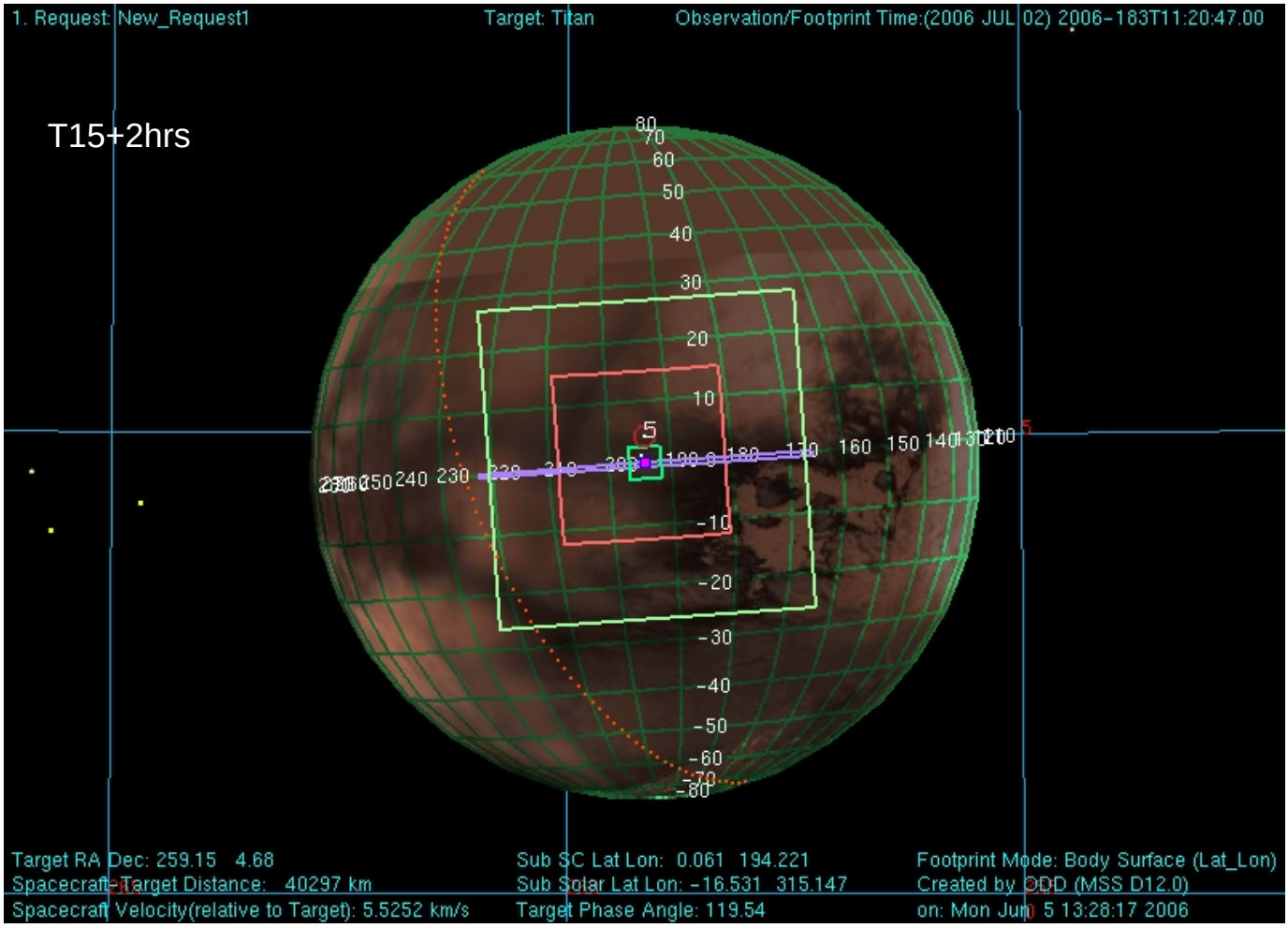
Instrument Field of View	Depiction in Figure
ISS WAC (imaging wide angle camera)	Largest square
VIMS (visual and infrared mapping spectrometer)	Next largest pink square
ISS NAC (imaging narrow angle camera)	Smallest green square
CIRS (composite infrared spectrometer) – Focal Plane 1	Small red circle near ISS_NAC FOV
UVIS (ultraviolet imaging spectrometer)	Vertical purple rectangle centered within largest square



View of Titan from Cassini 2 hours before Titan-15 closest approach



View of Titan from Cassini at Titan-15 closest approach



View of Titan from Cassini 2 hours after Titan-15 closest approach

Timeline and Geometry Table below

Cassini Titan-15 Timeline - July 2006

Colors: yellow = maneuvers; blue = geometry; pink = T15-related; green = data playbacks

Orbiter UTC	Ground UTC	Pacific Time	Time wrt T15	Activity	Description
154T02:39:00	Jun 03 04:02	Fri Jun 02 09:02 PM	T15-29d07h	Start of Sequence S21	Start of Sequence which contains Titan-15.
179T16:07:00	Jun 28 17:30	Wed Jun 28 10:30 AM	T15-03d17h	**OTM #64 Prime**	Titan-15 minus 3 day targeting maneuver
180T08:37:00	Jun 29 10:00	Thu Jun 29 03:00 AM	T15-03d01h	**OTM #64 Backup**	
182T17:22:00	Jul 01 18:45	Sat Jul 01 11:45 AM	T15-15h58m	Start of the TOST Segment	
182T17:22:00	Jul 01 18:45	Sat Jul 01 11:45 AM	T15-15h58m	Turn cameras to Titan	
182T17:52:00	Jul 01 19:15	Sat Jul 01 12:15 PM	T15-15h28m	Deadtime	Used to accommodate changes in flyby time
182T18:15:00	Jul 01 19:38	Sat Jul 01 12:38 PM	T15-15h05m	Infrared (IR) global mapping	Search for and characterize clouds.
182T19:50:00	Jul 01 21:13	Sat Jul 01 02:13 PM	T15-13h30m	Far IR stratospheric studies	Obtain information on CO, HCN, and CH4
182T23:20:00	Jul 02 00:43	Sat Jul 01 05:43 PM	T15-10h00m	Narrow Angle Camera (NAC) global map	Global mosaic looking for cloud activity
183T01:20:00	Jul 02 02:43	Sat Jul 01 07:43 PM	T15-08h00m	Mid IR limb observations	Obtain information on trace constituents in stratosphere
183T04:00:00	Jul 02 05:23	Sat Jul 01 10:23 PM	T15-05h20m	Turn RADAR toward Titan	
183T04:20:00	Jul 02 05:43	Sat Jul 01 10:43 PM	T15-05h00m	RADAR scatterometry and radiometry	Study surface and sub-surface properties
183T08:20:00	Jul 02 09:43	Sun Jul 02 02:43 AM	T15-01h00m	MAPS in-situ observations	Analysis of plasma wake, ions escaping from Titan, and Titan's interaction with Saturn's magnetosphere.
183T08:54:00	Jul 02 10:17	Sun Jul 02 03:17 AM	T15-00h26m	**Titan Wake Crossing**	
183T09:20:47	Jul 02 10:43	Sun Jul 02 03:43 AM	T15+00h00m	**Titan-15 Flyby Closest Approach Time**	**Altitude = 1906 km (1184 miles), speed = 5.8 km/s (13,000 mph); 148 deg phase at closest approach**
183T09:50:00	Jul 02 11:13	Sun Jul 02 04:13 AM	T15+00h30m	Far IR limb observation	Study stratospheric compounds, including H2O
183T11:50:00	Jul 02 13:13	Sun Jul 02 06:13 AM	T15+02h30m	UV spectral imaging scans across visible hemisphere	Analyze composition of upper atmosphere
183T17:20:00	Jul 02 18:43	Sun Jul 02 11:43 AM	T15+08h00m	Visible observations of dark side	Search for and monitor lightning/aurorae
183T18:20:00	Jul 02 19:43	Sun Jul 02 12:43 PM	T15+09h00m	Far IR stratospheric studies	Obtain information on CO, HCN, CH4
183T23:50:00	Jul 03 01:13	Sun Jul 02 06:13 PM	T15+14h30m	Mid IR stratospheric studies	analyze thermal structure (temperature map)
184T07:44:00	Jul 03 09:07	Mon Jul 03 02:07 AM	T15+22h24m	Deadtime	Used to accommodate changes in flyby time
184T07:52:00	Jul 03 09:15	Mon Jul 03 02:15 AM	T15+22h32m	Turn to Earth-Line	
184T08:22:00	Jul 03 09:45	Mon Jul 03 02:45 AM	T15+23h02m	Begin Playback of T15 Data	Madrid 34M
184T17:22:00	Jul 03 18:45	Mon Jul 03 11:45 AM	T15+01d08h	End Playback of T15 Data	Much of the T15 data will be returned during the playback on the following day.

OWLT (mins)	83
C/A Time	Sun Jul 02 03:43 AM

1.4 FLYBY GEOMETRY

Event Name: T15_25TI, Targeted Titan, Outbound. 050505 SPK: Table Creation Date (YYMMDD) 050712

Event Name at Event Time Only	SCET Date (YYYY-DOYTHH:MM:SS.FF) UTC	SCET Date (MM/DD/YYYY HH:MM:SS) UTC	SCET Date (MM/DD/YYYY HH:MM:SS) ET	Hours wrt Event Epoch	Minutes wrt Event Epoch	S/C Range (km)	S/C Altitude wrt Tri-axial Ellipsoid (km)	S/C North Latitude (deg)	S/C West Longitude SMEQPM Date (deg)	S/C Inertial Velocity (km/s)	S/C Radial Inertial Velocity (km/s)	S/C Tangential Inertial Velocity (km/s)	Central Body Angular Diameter (mrad)	Phase = Sun-Central_Body-S/C Angle (deg)	Sun-S/C Central_Body Angle (deg)	S/C Local True Solar Time wrt Central Body (hh:mm)	Sub-solar Latitude wrt Central Body (deg)	Sub-solar West Longitude wrt Central Body SMEQPM Date (deg)
	2006-182T09:20:48.20	01-Jul-06	09:21:52	-24	-1440	508,992.8	506,417.8	-0.1	-10.7	6.917	-6.917	0.031	10.1	60.0	120.0	06:05	-16.5	-69.3
	2006-182T13:20:48.20	01-Jul-06	13:21:52	-20	-1200	413,711.8	411,136.8	-0.1	-5.8	6.354	-6.352	0.118	12.4	60.2	119.8	06:04	-16.5	-65.5
	2006-182T15:20:48.20	01-Jul-06	15:21:52	-18	-1080	368,752.7	366,177.7	-0.1	-4.7	6.145	-6.143	0.136	14.0	60.3	119.7	06:04	-16.5	-63.6
	2006-182T17:20:48.20	01-Jul-06	17:21:52	-16	-960	325,155.2	322,580.2	-0.1	-2.7	5.975	-5.973	0.146	15.8	60.5	119.5	06:03	-16.5	-61.8
	2006-182T19:20:48.20	01-Jul-06	19:21:52	-14	-840	282,656.7	280,083.7	-0.1	-0.6	5.839	-5.837	0.151	18.2	60.7	119.3	06:02	-16.5	-59.9
	2006-182T21:20:48.20	01-Jul-06	21:21:52	-12	-720	241,040.2	238,465.2	-0.1	1.5	5.731	-5.729	0.157	21.4	60.9	119.1	06:01	-16.5	-58.0
	2006-182T23:20:48.20	01-Jul-06	23:21:52	-10	-600	200,108.3	197,533.3	-0.1	3.7	5.648	-5.645	0.168	25.7	61.2	118.8	06:00	-16.5	-56.1
	2006-183T01:20:48.20	02-Jul-06	01:21:52	-8	-480	159,698.2	157,123.2	-0.1	6.0	5.586	-5.583	0.190	32.2	61.6	118.4	07:59	-16.5	-54.2
	2006-183T03:20:48.20	02-Jul-06	03:21:52	-6	-360	119,667.3	117,092.3	-0.1	8.5	5.544	-5.539	0.234	43.0	62.2	117.8	07:56	-16.5	-52.4
	2006-183T04:20:48.20	02-Jul-06	04:21:52	-5	-300	99,754.9	97,179.9	-0.1	9.9	5.530	-5.524	0.274	51.6	62.6	117.4	07:54	-16.5	-51.4
	2006-183T05:20:48.20	02-Jul-06	05:21:52	-4	-240	79,893.2	77,318.2	-0.1	11.6	5.521	-5.511	0.335	64.5	63.3	116.7	07:51	-16.5	-50.5
	2006-183T06:20:48.20	02-Jul-06	06:21:52	-3	-180	60,071.8	57,496.8	-0.1	13.6	5.518	-5.501	0.440	85.8	64.4	115.6	07:47	-16.5	-49.5
	2006-183T07:20:48.20	02-Jul-06	07:21:52	-2	-120	40,291.2	37,716.2	-0.1	16.8	5.525	-5.487	0.651	127.9	66.5	113.5	07:38	-16.5	-48.6
	2006-183T08:20:48.20	02-Jul-06	08:21:52	-1	-60	20,624.9	18,049.9	-0.1	24.3	5.560	-5.413	1.268	250.4	72.7	107.3	07:12	-16.5	-47.7
	2006-183T08:50:48.20	02-Jul-06	08:51:52	-1	-30	11,068.3	8,493.3	-0.2	36.6	5.626	-5.106	2.362	469.6	84.0	96.0	06:24	-16.5	-47.2
	2006-183T09:05:48.20	02-Jul-06	09:06:52	0	-15	6,772.8	4,197.8	-0.3	55.1	5.717	-4.217	3.860	780.0	101.5	78.5	05:11	-16.5	-47.0
	2006-183T09:15:48.20	02-Jul-06	09:16:52	0	-5	4,790.7	2,215.7	-0.4	84.1	5.812	-2.000	5.457	1134.9	128.7	51.3	03:16	-16.5	-46.8
T15_25TI	**2006-183T09:20:48.20**	**02-Jul-06**	**09:21:52**	**0**	**0**	**4,480.8**	**1,905.8**	**-0.4**	**105.6**	**5.834**	**0.003**	**5.834**	**1224.4**	**147.9**	**32.1**	**01:50**	**-16.5**	**-46.7**
	2006-183T09:25:48.20	02-Jul-06	09:26:52	0	5	4,792.2	2,217.2	-0.3	127.0	5.812	2.005	5.455	1134.5	162.0	18.0	00:25	-16.5	-46.7
	2006-183T09:35:48.20	02-Jul-06	09:36:52	0	15	6,776.1	4,201.1	-0.2	156.0	5.717	4.219	3.858	779.6	152.2	27.8	22:30	-16.5	-46.5
	2006-183T09:50:48.20	02-Jul-06	09:51:52	1	30	11,072.6	8,497.6	-0.1	174.4	5.626	5.107	2.361	469.4	136.6	43.4	21:17	-16.5	-46.3
	2006-183T10:20:48.20	02-Jul-06	10:21:52	1	60	20,630.4	18,055.4	0.0	-173.2	5.560	5.414	1.267	250.3	125.6	54.4	20:29	-16.5	-45.8
	2006-183T11:20:48.20	02-Jul-06	11:21:52	2	120	40,299.3	37,724.3	0.1	-165.8	5.525	5.487	0.647	127.9	119.5	60.5	20:03	-16.5	-44.9
	2006-183T12:20:48.20	02-Jul-06	12:21:52	3	180	60,080.3	57,505.3	0.1	-162.6	5.517	5.500	0.431	85.7	117.4	62.6	19:54	-16.5	-43.9
	2006-183T13:20:48.20	02-Jul-06	13:21:52	4	240	79,895.2	77,320.2	0.1	-160.6	5.517	5.508	0.320	64.5	116.4	63.6	19:50	-16.5	-43.0
	2006-183T14:20:48.20	02-Jul-06	14:21:52	5	300	99,737.8	97,162.8	0.1	-159.0	5.522	5.516	0.250	51.6	115.8	64.2	19:47	-16.5	-42.0
	2006-183T15:20:48.20	02-Jul-06	15:21:52	6	360	119,610.8	117,035.8	0.1	-157.6	5.529	5.525	0.201	43.1	115.4	64.6	19:46	-16.5	-41.1
	2006-183T17:20:48.20	02-Jul-06	17:21:52	8	480	159,466.1	156,891.1	0.1	-155.2	5.548	5.547	0.132	32.3	114.9	65.1	19:44	-16.5	-39.2
	2006-183T19:20:48.20	02-Jul-06	19:21:52	10	600	199,495.5	196,920.5	0.1	-153.1	5.574	5.573	0.081	25.8	114.7	65.3	19:43	-16.5	-37.3
	2006-183T21:20:48.20	02-Jul-06	21:21:52	12	720	239,726.5	237,153.5	0.1	-151.1	5.603	5.603	0.037	21.5	114.5	65.4	19:42	-16.5	-35.5
	2006-183T23:20:48.20	02-Jul-06	23:21:52	14	840	280,186.9	277,613.9	0.1	-149.2	5.636	5.636	0.004	18.4	114.5	65.5	19:42	-16.5	-33.6
	2006-184T01:20:48.20	03-Jul-06	01:21:52	16	960	320,895.8	318,320.8	0.1	-147.4	5.672	5.672	0.045	16.0	114.5	65.4	19:42	-16.5	-31.7
	2006-184T03:20:48.20	03-Jul-06	03:21:52	18	1080	361,863.7	359,288.7	0.1	-145.6	5.709	5.709	0.087	14.2	114.6	65.4	19:42	-16.5	-29.8
	2006-184T05:20:48.20	03-Jul-06	05:21:52	20	1200	403,103.7	400,528.7	0.1	-143.8	5.749	5.747	0.130	12.8	114.7	65.3	19:43	-16.5	-28.0
	2006-184T09:20:48.20	03-Jul-06	09:21:52	24	1440	486,429.3	483,854.3	0.1	-140.4	5.831	5.826	0.223	10.6	115.0	65.0	19:44	-16.5	-24.2